

UNCLASSIFIED

AD **406 139**

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA



UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

ABSTRACT

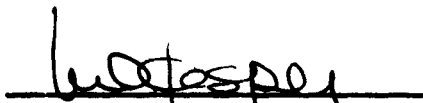
Helicopters are used extensively by the U. S. Navy in anti-submarine warfare, mine countermeasures, and search and rescue missions. If a helicopter crashes or is forced to ditch, the crew is unable to escape from the craft until it is in the water and the rotors have stopped. In most helicopter ditchings, the crew members must egress from a submerged or partially submerged cabin. Under these conditions, the ability to breathe underwater, even for a short time, is invaluable.

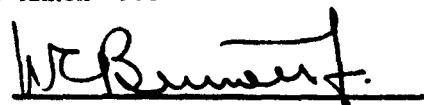
This report describes an emergency breathing apparatus developed at the U. S. Navy Mine Defense Laboratory which will permit crew members to submerge with the aircraft and make an unhurried, safe, underwater exit. A 15-minute breathing supply is provided in a lightweight, compact, simple and easily maintainable package, which can be used by almost anyone after a short period of instruction.

ADMINISTRATIVE INFORMATION

This task was established and work commenced in April 1960 as a part of WEPTASK RUDC 6B 000/439-2/F011-02-002, and was completed in November 1962 under WEPTASK RUME 2B 000/439-1/F011-02-03. Besides the author, a number of persons at the U. S. Navy Mine Defense Laboratory have contributed important efforts toward the successful completion of the task, notably Mr. William Quigley and Mr. Ted Haney, both currently in the Minehunting Branch.

APPROVED AND RELEASED 5 MARCH 1963


N. H. Jesper, Dr. Eng.
Technical Director


W. C. Bennett, Jr., CAPT, USN
Commanding Officer and Director

INITIAL DISTRIBUTION LIST
REPORT 197

Chief, Bureau of Naval Weapons

(RUME 2) (50 Copies)

(RUME 3) (3 Copies)

Chief, Bureau of Ships

(Code 831) (3 Copies)

(Code 838) (3 Copies)

(Code 210L) (3 Copies)

(Code 320) (1 Copy)

Chief, Office of Naval Research

(Code 463) (2 Copies)

Commanding Officer, U. S. Naval Air Material Center,

(Air Crew Equipment Laboratory) (3 Copies)

U. S. NAVY MINE DEFENSE LABORATORY
PANAMA CITY, FLORIDA

IN REPLY REFER TO:

Code 722

From: Commanding Officer and Director, U. S. Navy Mine Defense Laboratory,
Panama City, Florida
To: DISTRIBUTION LIST

Subj: NAVMINDEFLAB Unclassified Report 197; information concerning

1. The development of the emergency breathing apparatus was undertaken in order to provide a greater measure of safety for the crews of helicopters which must operate over water. The application of this device will benefit pilots and air crewmen in all types of helicopter operations, and can even benefit crews of conventional aircraft operating from aircraft carriers.
2. The purpose of this report is to properly document the information it contains, and to distribute it to interested activities.
3. It is recommended that this device be adopted for use by crews of all Anti-Submarine Warfare, Rescue, and Mine Countermeasures helicopters.
4. The report is forwarded to the Bureau of Weapons for action as appropriate, and to all other addressees for information.

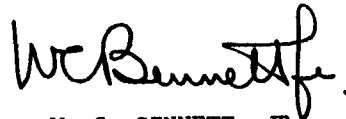

W. C. BENNETT, JR.

TABLE OF CONTENTS

	<u>Page No.</u>
INTRODUCTION	3
TECHNICAL APPROACH	3
DESCRIPTION OF EQUIPMENT	6
PERFORMANCE	12
SUMMARY	15
CONCLUSIONS	15
RECOMMENDATIONS	15
REFERENCES	15
APPENDIX A - OPERATING PROCEDURES	17

LIST OF ILLUSTRATIONS

<u>Figure No.</u>		<u>Page No.</u>
1	Emergency Breathing Apparatus - Front View	7
2	Emergency Breathing Apparatus - Rear View	8
3	Emergency Breathing Apparatus - Disassembled for Cleaning	9
4	Emergency Breathing Apparatus - With Jacket Open	10
5	Jumping With Emergency Breathing Apparatus	11
6	Regulated Pressure and Gas Flow Rate Versus Time	13
7	Emergency Breathing Apparatus Bottom Time, Flow Rate, and Depth Versus Per Cent Oxygen in Breathing Gas Mixture	14
A1	Pressure Reducer	19

INTRODUCTION

Helicopters engaged in mine countermeasures and anti-submarine warfare usually fly over the water at low altitudes. Should the helicopter have to ditch, the crew must remain in the cabin until the rotors have been stopped. In many instances, the cabin will be completely submerged before the crew members may escape safely.

TECHNICAL APPROACH

In order to escape from a submerged helicopter, the crew of the aircraft must have breathing equipment at hand ready for instant use in the emergency. This suggests that the equipment be carried attached to the person who would use it in the same manner as a parachute or oxygen supply. In order to permit this type of application, the equipment must be of lightweight, not bulky, and comfortable to wear.

The helicopter might be expected to sink rapidly once its complete immersion occurs, and if a crewman were injured and required assistance, the helicopter might easily be 50 to 60 feet deep before all the crew escapes. If the water is known to be shallow, the crew might prefer to stay in the aircraft until it grounds rather than attempt an escape during the descent. It is very desirable, therefore, to have an apparatus which is useful at depths of at least 50 feet and which has capacity sufficient to allow safe breathing for several minutes.

There are three basic types of underwater breathing apparatus in use today. These are:

1. Open circuit
2. Closed circuit
3. Semiclosed circuit

Open circuit apparatuses do not recirculate their breathing medium. The user inhales the medium from a regulated air supply, and exhales all gas into the water. Such systems can use a variety of gases and mixtures, but compressed air is the most practical. Inhaled, or ambient air is approximately 21 per cent oxygen and 79 per cent nitrogen. When

exhaled at atmospheric pressure, the composition is changed to 80 per cent nitrogen, 16 per cent oxygen and 4 per cent carbon dioxide. Since the breathing person consumes only about 5 per cent of the gas he breathes, a swimmer using open circuit apparatus near the surface discharges 95 per cent of his total gas supply into the water. At a depth of 66 feet, the waste increases to about 99 per cent. The inherently low efficiency of the open circuit apparatus makes necessary the use of large tanks to accommodate the volume of air required, making them very cumbersome to wear, especially when not underwater.

The closed-circuit apparatus usually uses pure oxygen as a breathing medium and recirculates the exhaled gas through a carbon dioxide absorber into a breathing bag for re-use. While compact and efficient, this equipment cannot be used safely at depths greater than 30 feet because of oxygen toxicity, and the breathing bag must be carefully purged before each dive to eliminate the inert nitrogen gas both from the bag and from the divers's lungs. These requirements remove closed-circuit apparatus from consideration, since the helicopter crewmen would not have time to get ready to use the equipment, and its safe depth is insufficient.

A semiclosed circuit apparatus may use either a nitrogen-oxygen or helium-oxygen mixture, and provides an automatic continual purge of the breathing bag during use. This type of apparatus is a hybrid which obtains the best features of the parent types with reduction of their undesirable traits. The semiclosed circuit apparatus exposes its user to the hazards of anoxia, or oxygen deficiency. Should the flow of oxygen be stopped for any reason, the oxygen content in the breathing bag dwindles with each breath, until finally the mixture cannot sustain life. Unless the user is able to detect the stoppage, somehow, and return to the surface, he will gradually become unconscious. To reduce the possibility of anoxia, and to permit the use of more compact gas storage tanks, the percentage of oxygen in the mixture should be high, but not high enough to cause danger of oxygen toxicity. Oxygen toxicity or poisoning is probable if the partial pressure of oxygen in a mixture is equal to or greater than two atmospheres absolute pressure. The symptoms of toxicity are muscular twitching, nausea, dizziness, abnormal vision and hearing, anxiety, confusion, and finally, convulsions. If a diver reaches the stage of convulsions underwater, his death is very probable.

The design considerations naturally point to the adoption of a semiclosed circuit apparatus, because it is more compact and efficient than the open circuit type, and is safer and much easier to use than the closed circuit type. It is desirable to utilize as many standard components as possible in the design to reduce the effort required for both design and testing. After a preliminary study, the standard components to be used were selected and procured.

The optimum gas mixture must obtain a proper balance between richness in oxygen and freedom from toxicity to the selected depth. The Relative Oxygen Depth is defined as the depth on pure oxygen which is equivalent to the partial pressure of oxygen in a mixture at an actual depth. It is calculated from the following formula:

$$D = O(d + 33) - 33 \quad (1)$$

where D is the Relative Oxygen Depth

O is the fraction of the mixture which is oxygen

d is the diving depth.

Using d = 50 feet, and a gas mixture which is 75 per cent oxygen and 25 per cent nitrogen, the above formula gives a relative oxygen depth of 29.25 feet. This is just under the maximum safe depth of 30 feet on pure oxygen, and NAVSHIPS Manual 250-538 indicates that this mixture is safe for 45 minutes at a depth of 50 feet.

A normal person engaged in work which demands considerable physical exertion may consume oxygen at the rate of three liters per minute. This rate depends only upon the individual and the effort expended. The maximum permissible fraction of oxygen in a breathing gas mixture is given by the formula:

$$O = \frac{2 \times 33}{d + 33} \quad (2)$$

where O and D are the same quantities as used in Equation (1). The number 33 is the height in feet of a column of water which produces a pressure at its base equal to one atmosphere. Using a value for d of 50 feet, the maximum per cent oxygen is found to be 79.5 per cent. The mixture selected is 75 per cent oxygen and 25 per cent nitrogen to simplify the splitting and mixing of the gas supply. The maximum permissible depth for this mixture may be calculated also from a transposition of Equation (2), and is 55 feet.

To maintain a minimum amount of oxygen in the breathing bag while the device is in use, fresh mixture must be injected into the system at some rate. This injection rate may be calculated from the formula:

$$O_b = \frac{OR - C}{R - C} \quad (3)$$

where O_b is the fraction of oxygen in the contents of the breathing bag,

O is the fraction of oxygen in the mixture being injected,

R is the rate in liters per minute at which fresh mixture enters the system, and

C is the rate at which the user is consuming oxygen in liters per minute.

If we desire the oxygen content of the bag to be about the same as that of fresh air, O_b is fixed at 0.21. The value of O was already chosen as 0.75. For C of 3 liters per minute, the injection rate of fresh gas is 4.4 liters per minute. Since 3 liters per minute is a maximum rate, and a more probable rate is about 1.5 liters per minute, the actual per cent oxygen in the bag will be about 62 per cent. The relative oxygen depth for this bag mixture is about 18.5 feet. Therefore the 4.4 liters per minute injected into the system will assure sufficient oxygen to support extreme exertion, but will not endanger the user from toxicity even if the demand is much smaller. A relative oxygen depth of 19 feet would permit the user to remain underwater for up to 110 minutes, which is much longer than the supply of gas will last. In emergencies, a user could go to a depth of 77 feet with the 75 per cent oxygen mixture with only a slight reduction in submergence time.

DESCRIPTION OF EQUIPMENT

Figures 1 through 4 are photographs which show the completed apparatus. The resemblance to equipment currently in use by aviators and divers results from adoption of components already in use wherever possible. Figure 5 is a photograph of one test during which the user jumped from a hovering helicopter into the water with the apparatus to demonstrate that it would survive the shock, not injure the wearer, and still operate normally. The appendix gives the operating and servicing instructions.

The present model is an experimental one intended to demonstrate the soundness of the basic idea. It contains some parts which should probably be redesigned or made of different materials to reduce cost, weight, or possible trouble from electrolysis in sea water. Drawings are available at the U. S. Navy Mine Defense Laboratory where the present model was constructed.

(Text Continued on Page 12)

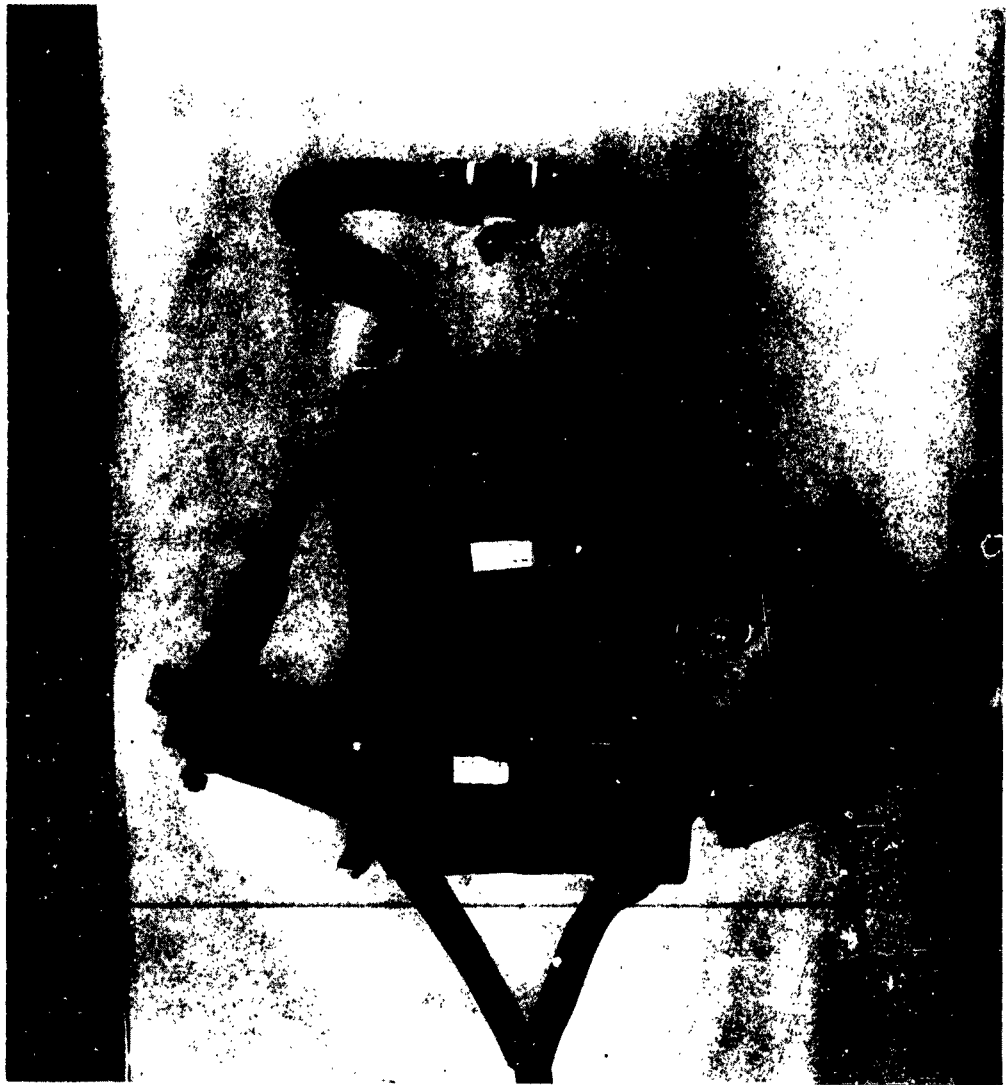


FIGURE 1. EMERGENCY BREATHING APPARATUS - FRONT VIEW

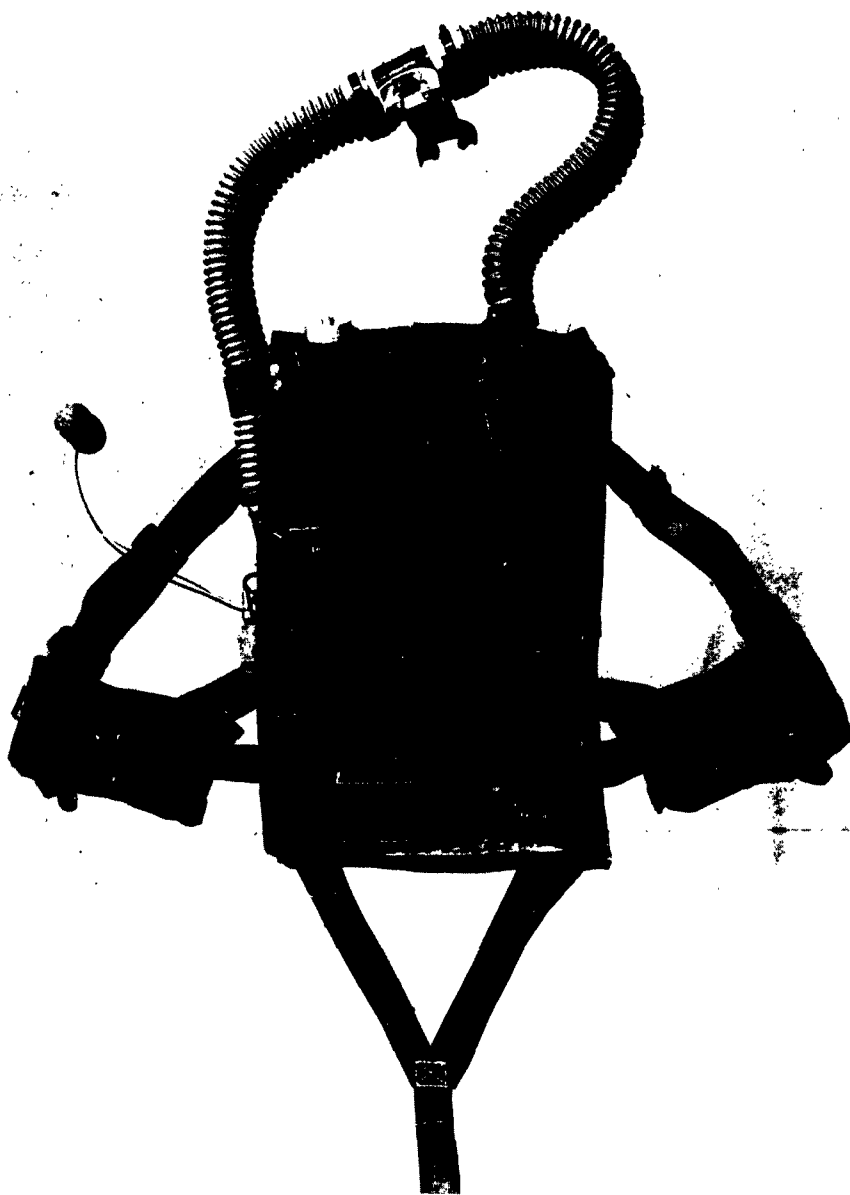


FIGURE 2. EMERGENCY BREATHING APPARATUS - REAR VIEW

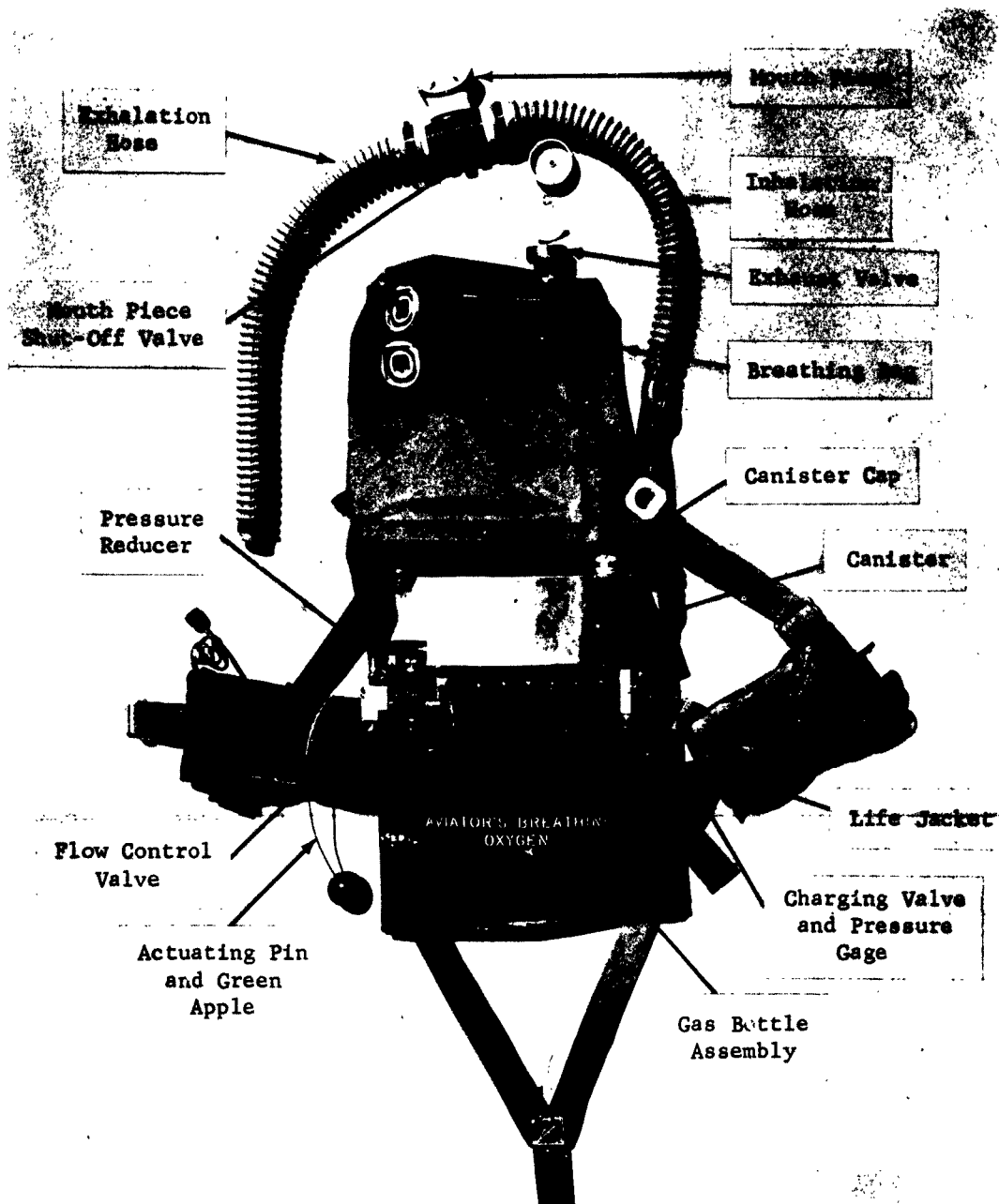


FIGURE 3. EMERGENCY BREATHING APPARATUS - DISASSEMBLED FOR CLEANING

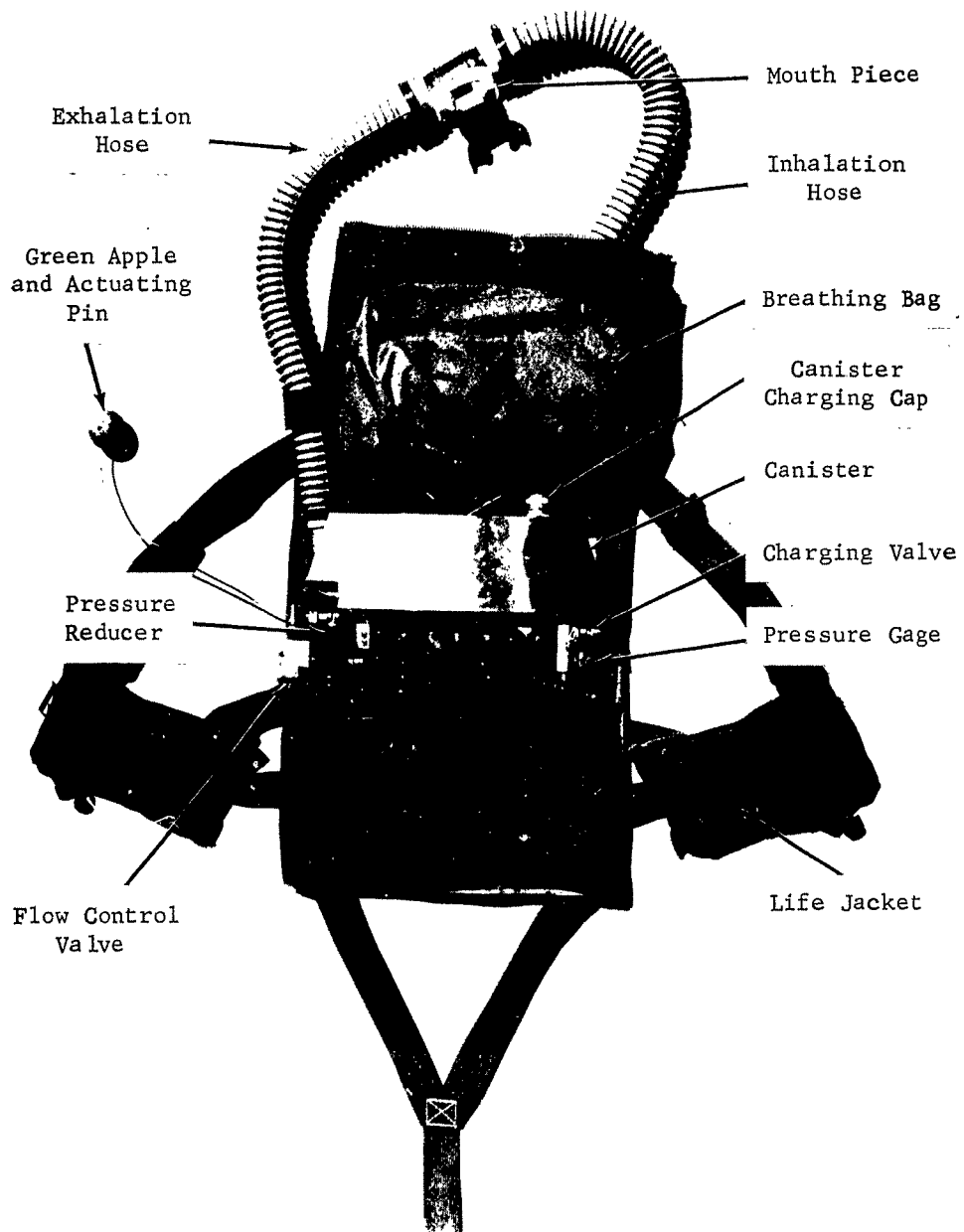


FIGURE 4. EMERGENCY BREATHING APPARATUS - WITH JACKET OPEN



FIGURE 5. JUMPING WITH EMERGENCY BREATHING APPARATUS

The emergency breathing apparatus consists of a gas supply bottle assembly with a pressure reducer and flow control valve, a cannister of carbon dioxide absorbent, a breathing bag, an inhalation hose, a mouthpiece assembly containing inhalation and exhalation check valves, an exhalation hose, and a back-pack jacket with life preservers. These parts are labeled in Figures 3 and 4. The breathing gas mixture is metered from the bottle assembly at a pre-set flow rate, and enters the absorbent cannister. The gas is injected at this point merely for convenience, and could have entered the system almost at any point. From the injection point, the gas travels to the breathing bag, where it is stored until it is used. When the user inhales, he draws air to the mouthpiece through the inhalation hose, past the inhalation check valve on the right-hand side of the mouthpiece, and it enters his lungs. Upon exhalation, the used gas flows through the exhalation check valve on the left side of the mouthpiece to the exhalation hose, absorbent cannister which removes the carbon dioxide, and back into the breathing bag. As the pressure in the breathing bag rises because of the constant injection of fresh gas, an exhaust valve bleeds excess gas from the bag into the water, maintaining a continual purge of the system.

The operation of this apparatus is simple, and if the calculated limits are carefully observed, there is very little danger in the use of it. Because of the danger which can exist from oxygen toxicity and from anoxia, it should not be used for routine diving, except by persons qualified in mixed gas diving.

PERFORMANCE

The gas supply bottle has a volume of 1 liter. At a pressure of 1800 psi, the capacity is 123 liters of gas measured at atmospheric pressure. The regulated pressure increases slightly as the bottle pressure drops, giving an increase in the injection rate. Figure 6 shows how the flow rate and regulated pressure vary over the discharge period. Tests reveal a flow period of 25 minutes starting with a bottle pressure of 1800 psi and an initial flow rate of 4.4 liters per minute. All flow adjustments should be made with a fully charged bottle. Actual diving times of 15 minutes to a depth of 60 feet have been achieved easily without exhausting the gas supply. Some divers actuate the by-pass valve excessively, so there is a wide variation in bottom times achieved by individuals.

Gas samples were taken at random times from the inhalation hose. The minimum oxygen content measured was 47 per cent, and the maximum carbon dioxide content was 0.8 per cent. Figure 7 shows performance curves using mixtures of oxygen and nitrogen ranging from 50 per cent to 100 per cent oxygen.

(Text Continued on Page 15)

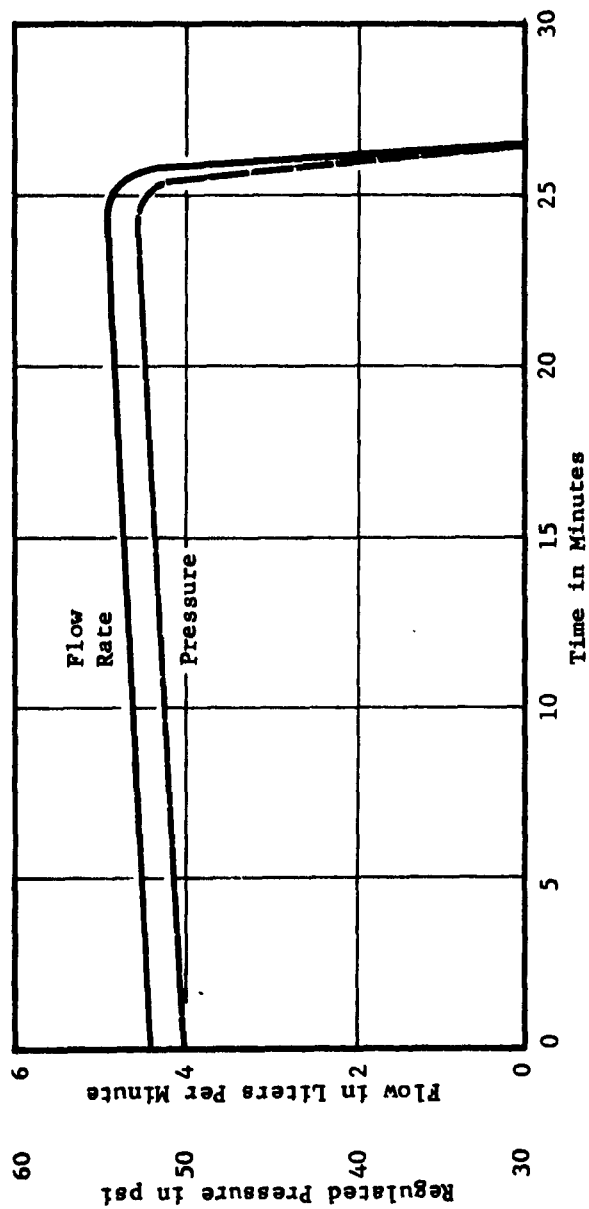


FIGURE 6. REGULATED PRESSURE AND GAS FLOW RATE VERSUS TIME

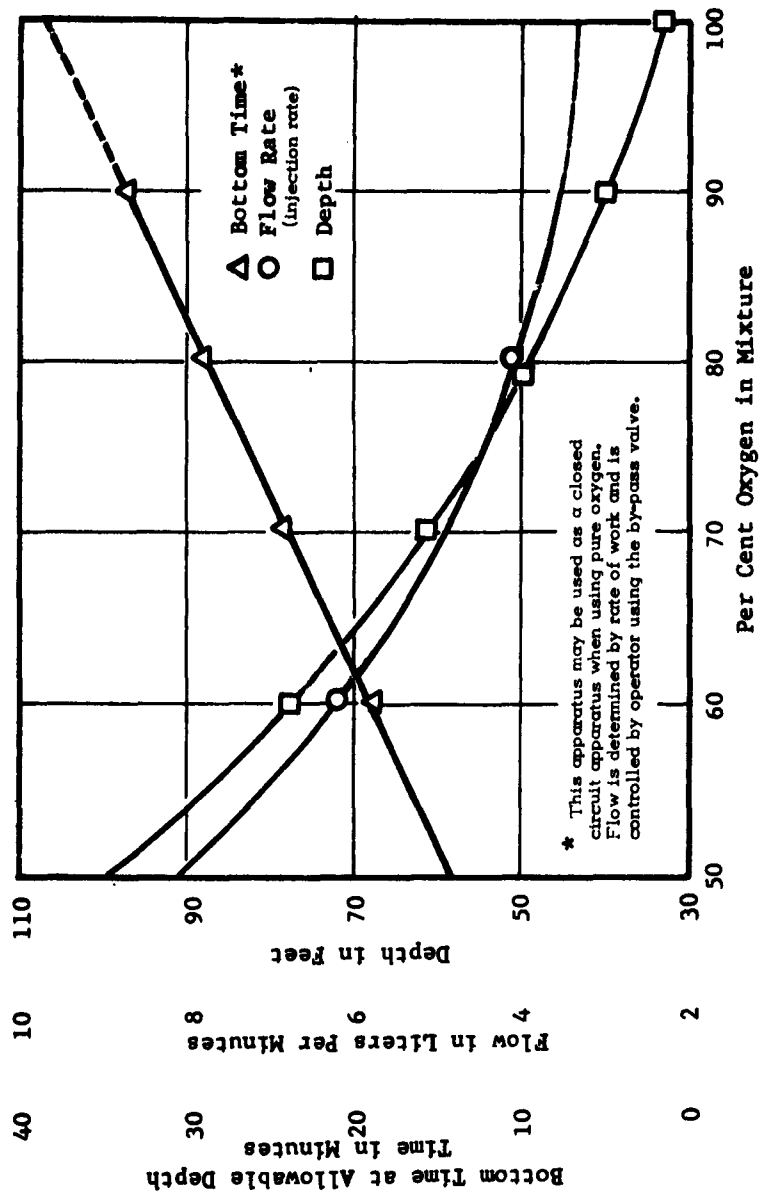


FIGURE 7. EMERGENCY BREATHING APPARATUS BOTTOM TIME, FLOW RATE, AND DEPTH VERSUS PER CENT OXYGEN IN BREATHING GAS MIXTURE

SUMMARY

This equipment can be used by personnel who face the hazards of aircraft ditching or water crashes, and can be used also by persons attempting rescue of personnel in downed aircraft or for the recovery of missiles or capsules. It permits a dive of short duration with a compact equipment which will not encumber use of safety harness. It does not unduly expose the user to oxygen toxicity or anoxia even at depths slightly exceeding its designed depth of 50 feet.

CONCLUSIONS

The emergency breathing apparatus has been designed and tested. Its performance is satisfactory for its intended use in mine counter-measures helicopters, and it could be used by crews of aircraft throughout the Navy with a potential to save lives of airmen who crash in water.

RECOMMENDATIONS

It is recommended that the emergency breathing apparatus be evaluated and, pending successful completion of all required tests, that it be adopted by the Navy for use by crews of aircraft which are subject to possible water crashes.

REFERENCES

1. (Author Unknown), "U. S. Navy Diving Manual, NAVSHIPS 250-538," Parts 1 and 3, (January 1959) UNCLASSIFIED.

(Reverse Page 16 Blank)

APPENDIX A
OPERATING PROCEDURES

The following procedures are presented for use with the Emergency Breathing Apparatus (EBA). (See Figures 3 and 4.)

W A R N I N G

1. THE DEVICE SHOULD BE USED BY QUALIFIED PERSONNEL ONLY.
2. PETROLEUM PRODUCTS SHOULD NOT BE PERMITTED TO CONTACT ANY COMPONENTS.
3. USE DOW-CORNING DC-4 FOR LUBRICATION AS NECESSARY.

1. Preparation for use.

a. Charge gas supply bottle assembly.

(1) Remove gas supply bottle assembly from EBA fabric jacket by opening zipper.

(2) Engage actuating pin if released.

(3) Remove charging valve cap.

(4) Purge charging line (from suitable external gas supply).

(5) Connect charging line to charging valve.

(6) Open external gas supply valve and charge to 2000 psi.

(7) Close external gas supply valve.

(8) Disconnect charging line.

(9) Replace charging valve cap.

b. Adjust gas flow and pressure.

(1) Disconnect tube between the canister and the flow control valve at the valve connection.

(2) Install pressure gauge on tube fitting.

- (3) Extract release pin.
- (4) Check reducer outlet pressure for 55 psi \pm 5 psi.
- (5) If gauge is not within limits, refer to pressure regulator, Figure A-1, and proceed as follows:
 - (a) Loosen set screw (part No. 8) in cam lever (part No. 7),
 - (b) Remove pin (part No. 9),
 - (c) Lift washer (part No. 10), and
 - (d) Set pressure by adjusting nut (part No. 11).
- (6) Reassemble and check pressure.
- (7) Engage release pin.
- (8) Disconnect pressure gauge.
- (9) Install flowmeter.
- (10) Remove, clean, and install flow control valve stem.
- (11) Extract release pin.
- (12) Set flow at 4.4 liters per minute (LPM) by turning flow control valve stem (drawing available at NAVMINDEFLAB).
- (13) Engage release pin.
- (14) Extract release pin and note flow constant at 4.4 LPM. As gas supply is exhausted, the flow rate will increase approximately 0.2 LPM.
- (15) Disconnect flowmeter.
- (16) Connect tube between canister and flow control valve.
- (17) Engage release pin.
- (18) Recharge bottle assembly to 2000 psi as instructed above.
- (19) Check for leaks by submerging in water.

(Text Continued on Page 20)

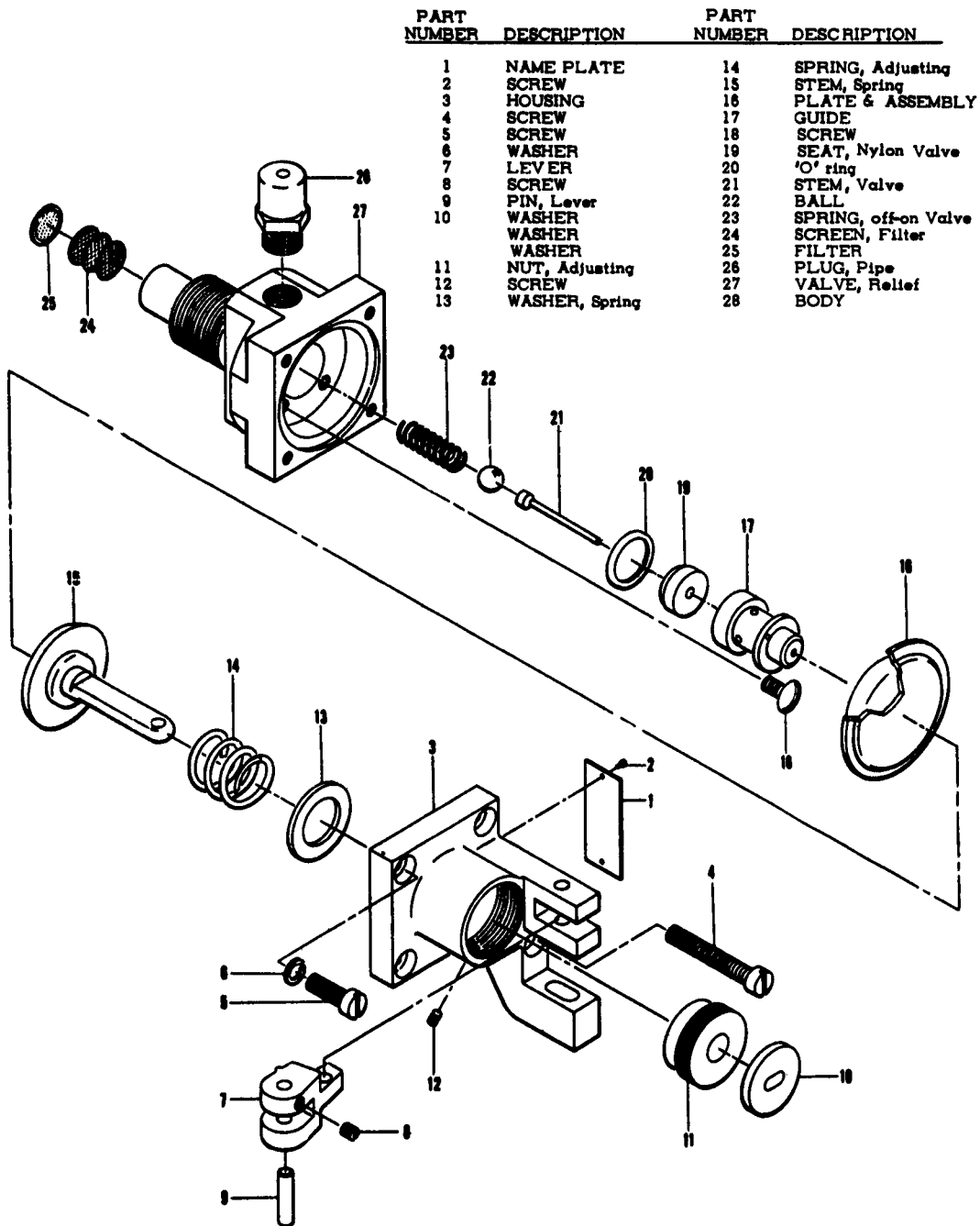


FIGURE A1. PRESSURE REDUCER

c. Filling absorbent canister.

- (1) Remove canister cap.
- (2) With inhalation and exhalation hoses loose, blow dust and moisture out, using oil-free air.
- (3) Fill canister with barslyme (barium and calcium hydroxide made by Thomas A. Edison Co., manufacturer's stock No. 11 28 62). Tap the sides and shake to compact pellets. If canister is not completely filled, gas will bypass the absorbent.
- (4) Install canister cap.
- (5) Blow dust from canister by alternately blowing 25 to 100 psi oil-free air through the intake and exhaust ports. Connect breathing hoses.
- (6) Insert gas bottle assembly into its fabric jacket.

2. Preflight check.

a. The following preflight check-out procedures apply:

- (1) Don the apparatus and adjust straps to fit comfortably.
- (2) Insert mouthpiece in mouth and open mouthpiece shut-off valve.
- (3) Check mouthpiece flow control. Check valves by blocking left hose and exhaling, then block right hose and inhale. If any leakage occurs, check or replace mouthpiece assembly. Any serious leakage of these valves will result in anoxia or a carbon dioxide build-up.
- (4) Check breathing bag for leaks by holding exhaust valve closed and filling the breathing bag by exhaling through the mouthpiece.
- (5) Set the exhaust pressure to a comfortable level by screwing exhaust valve cover in or out.
- (6) Evacuate breathing bag and close mouthpiece shut-off valve.
- (7) Check gas pressure gauge.
- (8) The unit is now ready for operation.

3. Use in emergency.

a. The following procedure is applicable:

- (1) Insert mouthpiece and open mouthpiece shut-off valve.
- (2) Exhale into bag while actuating bypass valve prior to submerging.
- (3) Pull "green apple" to extract release pin and hold in the extended position to actuate bypass valve. Release the "green apple" when the breathing bag is operating. On descent the bypass may require intermittent actuation as the pressure increases and the breathing bag volume decreases. A nose clip can be used if desired (nose clip retaining line should be looped around breathing hose readily accessible).
- (4) Breathe normally on descent and ascent.

W A R N I N G

UNDER NO CONDITION SHOULD THE OPERATOR HOLD HIS BREATH ON THE ASCENT. SERIOUS LUNG DAMAGE AND EMBOLISM MAY RESULT.

- (5) After arriving on surface, close mouthpiece shut-off valve and pull life jacket actuating levers to inflate buoyancy cells.

4. Post dive maintenance.

a. The following procedures should be followed:

- (1) Install release pin.
- (2) Wash EBA with fresh water.
- (3) Disassemble unit.
- (4) Wash breathing hoses inside and out.
- (5) Wash breathing bag inside and out.
- (6) Dump baralyme from canister and wash dust from inside canister.
- (7) Dry components with dry, oil-free air.
- (8) Repack life jacket.
- (9) Prepare for reuse.

Navy Mine Defense Laboratory. Report 197.
DEVELOPMENT OF EMERGENCY BREATHING
APPARATUS by W. T. Odum. April 1963.
21 p., illus., photos. UNCLASSIFIED

References: 1 ref.
Helicopters are used extensively by the U. S. Navy
in anti-submarine warfare, mine countermeasures, and
search and rescue missions. If a helicopter crashes
or is forced to ditch, the crew is unable to escape
from the craft until it is in the water and the rotors
have stopped. In most helicopter ditchings, the crew
members must egress from a submerged or partially
submerged cabin. Under these conditions, the ability
to breathe underwater, even for a short time, is
invaluable.

(over)

1. Underwater breathing apparatus - Development
2. Helicopters - Ditching
3. Safety measures -
4. Air sea rescue -
- I. Title
- II. Odum, W. T.
- III. Emergency Breathing
- IV. WEPTASK RUME 2B 000/439-1/F011 02 03

UNCLASSIFIED

Navy Mine Defense Laboratory. Report 197.
DEVELOPMENT OF EMERGENCY BREATHING
APPARATUS by W. T. Odum. April 1963.
21 p., illus., photos. UNCLASSIFIED

References: 1 ref.
Helicopters are used extensively by the U. S. Navy
in anti-submarine warfare, mine countermeasures, and
search and rescue missions. If a helicopter crashes
or is forced to ditch, the crew is unable to escape
from the craft until it is in the water and the rotors
have stopped. In most helicopter ditchings, the crew
members must egress from a submerged or partially
submerged cabin. Under these conditions, the ability
to breathe underwater, even for a short time, is
invaluable.

(over)

1. Underwater breathing apparatus - Development
2. Helicopters - Ditching
3. Safety measures -
4. Air sea rescue -
- I. Title
- II. Odum, W. T.
- III. Emergency Breathing
- IV. WEPTASK RUME 2B 000/439-1/F011 02 03

UNCLASSIFIED

Navy Mine Defense Laboratory. Report 197.
DEVELOPMENT OF EMERGENCY BREATHING
APPARATUS by W. T. Odum. April 1963.
21 p., illus., photos. UNCLASSIFIED

References: 1 ref.
Helicopters are used extensively by the U. S. Navy
in anti-submarine warfare, mine countermeasures, and
search and rescue missions. If a helicopter crashes
or is forced to ditch, the crew is unable to escape
from the craft until it is in the water and the rotors
have stopped. In most helicopter ditchings, the crew
members must egress from a submerged or partially
submerged cabin. Under these conditions, the ability
to breathe underwater, even for a short time, is
invaluable.

(over)

1. Underwater breathing apparatus - Development
2. Helicopters - Ditching
3. Safety measures -
4. Air sea rescue -
- I. Title
- II. Odum, W. T.
- III. Emergency Breathing
- IV. WEPTASK RUME 2B 000/439-1/F011 02 03

UNCLASSIFIED

Navy Mine Defense Laboratory. Report 197.
DEVELOPMENT OF EMERGENCY BREATHING
APPARATUS by W. T. Odum. April 1963.
21 p., illus., photos. UNCLASSIFIED

References: 1 ref.
Helicopters are used extensively by the U. S. Navy
in anti-submarine warfare, mine countermeasures, and
search and rescue missions. If a helicopter crashes
or is forced to ditch, the crew is unable to escape
from the craft until it is in the water and the rotors
have stopped. In most helicopter ditchings, the crew
members must egress from a submerged or partially
submerged cabin. Under these conditions, the ability
to breathe underwater, even for a short time, is
invaluable.

(over)

1. Underwater breathing apparatus - Development
2. Helicopters - Ditching
3. Safety measures -
4. Air sea rescue -
- I. Title
- II. Odum, W. T.
- III. Emergency Breathing
- IV. WEPTASK RUME 2B 000/439-1/F011 02 03

UNCLASSIFIED

This report describes an emergency breathing apparatus developed at the U. S. Navy Mine Defense Laboratory which will permit crew members to submerge with the aircraft and make an unhurried, safe, underwater exit. A 15-minute breathing supply is provided in a lightweight, compact, simple and easily maintainable package, which can be used by almost anyone after a short period of instruction.

UNCLASSIFIED

This report describes an emergency breathing apparatus developed at the U. S. Navy Mine Defense Laboratory which will permit crew members to submerge with the aircraft and make an unhurried, safe, underwater exit. A 15-minute breathing supply is provided in a lightweight, compact, simple and easily maintainable package, which can be used by almost anyone after a short period of instruction.

UNCLASSIFIED

This report describes an emergency breathing apparatus developed at the U. S. Navy Mine Defense Laboratory which will permit crew members to submerge with the aircraft and make an unhurried, safe, underwater exit. A 15-minute breathing supply is provided in a lightweight, compact, simple and easily maintainable package, which can be used by almost anyone after a short period of instruction.

UNCLASSIFIED

This report describes an emergency breathing apparatus developed at the U. S. Navy Mine Defense Laboratory which will permit crew members to submerge with the aircraft and make an unhurried, safe, underwater exit. A 15-minute breathing supply is provided in a lightweight, compact, simple and easily maintainable package, which can be used by almost anyone after a short period of instruction.

UNCLASSIFIED